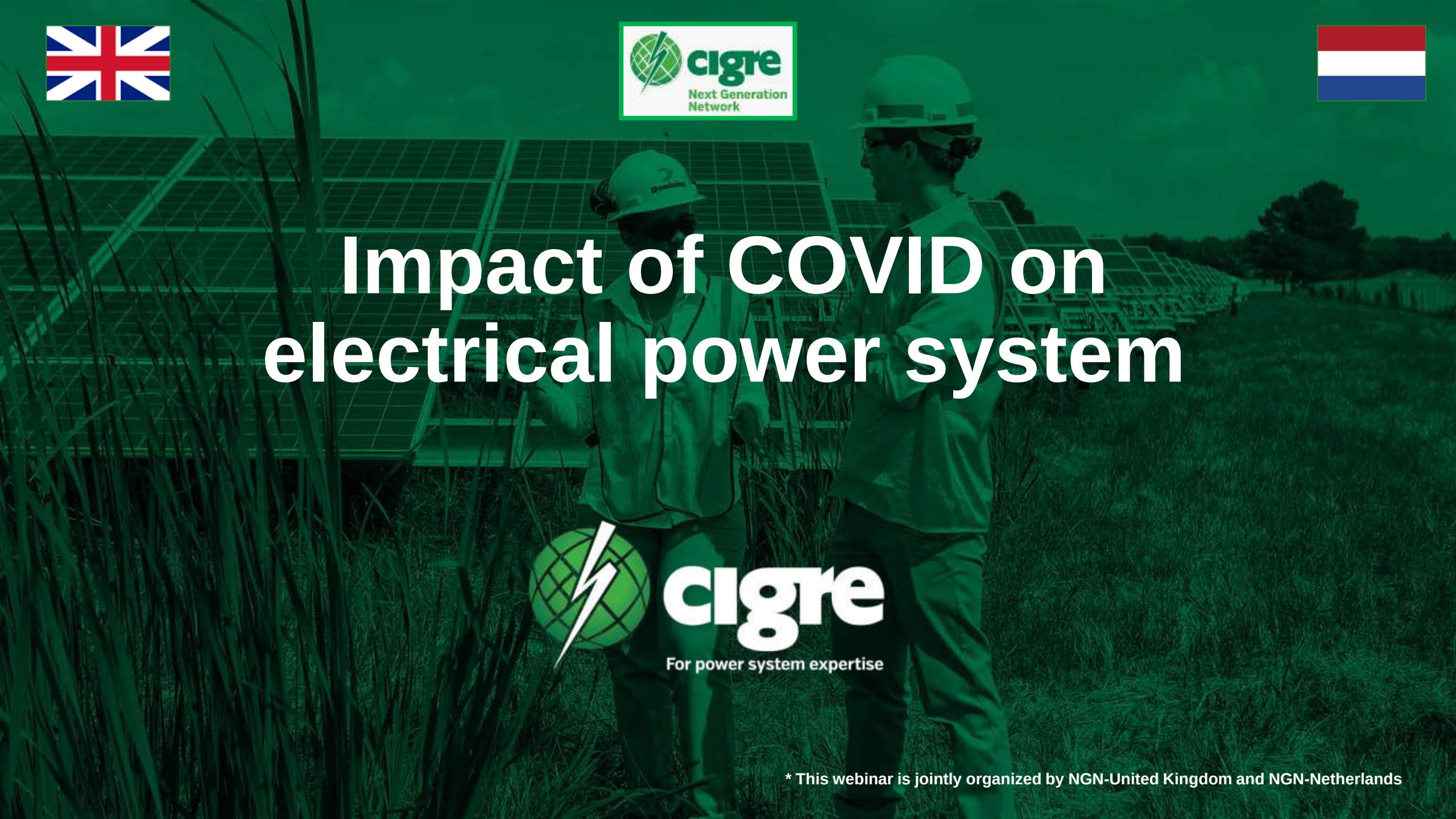

Impact of COVID on electrical power system

For power system expertise

* This webinar is jointly organized by NGN-United Kingdom and NGN-Netherlands

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15:00 – 15:05 Welcome

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This webinar is jointly organized by NGN-United Kingdom and NGN-Netherlands

Next Generation Network – United Kingdom

Dr. Kelly Loukatou

What is the Next Generation Network?

"The gateway to CIGRE"

A professional network for engineers studying or in the early stages of their career in the power industry.

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For power system expertise

Introduction – The Team

Angeliki Loukatou

Victor Timmers

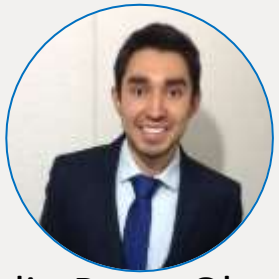
Diptargha Chakravorty

Jennifer McCartney

Jianing Li

Jingyi Wan

Haichuan Yu



Julio Perez Olvera

Max McFarlane

Introduction – The Team

Melike Ayaz

Asimina Frosinou

Phillip Paradine

Zongwen Yan

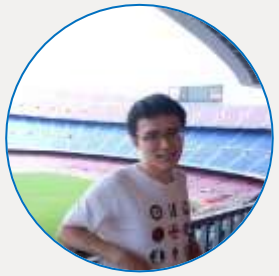
Qiteng Hong

Shahriar Muttalib

Xiaolong Hu

Ying Xue

Stefan Borozan



Zhenkun Yang

10+ Years of the UK NGN

- Set up in 2007
- CIGRE's 1st Young Member group
- 10 year anniversary in October 2017
- Steady active membership base:
  - Total current members 241
  - Female 20% Male 80%
  - Student 43% Industry 57%

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Benefits of Joining the NGN

- Free
  - For students
  - First 3 years for young professionals
- NGN events
- Get involved in CIGRE activities:
  - Join international Working Groups
  - Support CIGRE-UK Shadow Study Committee Panels
  - Join the NGN Steering Committee
  - Publish Papers in Working Groups and CIGRE conferences
- Personal Development and route to Chartership
- Remember: You don’t need to be an expert to join!

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Previous Events

- Connah's Quay Technical Event
- Cofely London Olympic Park Energy Centre
- Dinorwig Power Station Technical Visit
- Alstom Grid VSC Demonstrator Tour & Talks
- West Burton Power Station & National Grid Electricity Substation Tour
- Visit to the Culham Centre for Fusion Energy
- "Current and Future Challenges for Electrical Power Systems" & NGN Annual General Meeting
- Distribution Innovation Challenge
- Integration of Renewables
- Western Link Visit
- Evolution of System Operation & NGN AGM
- Power Networks Demonstration Centre
- Visit to Grain Power Station
- Future Electricity Networks and CIGRE UK NGN AGM
- CIGRE-UK NGN: Hunterston B Power Station Visit
- YM Showcase: UK Rep Selection+Lab Tours (Graphene, HV, RTDS & Storage)
- Webinar for first time attendees to Paris Session
- Young Member Informal Welcome & Networking
- Young Member Forum
- Young Member Technical Event

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A Few Recent Events

Neilston substation visit

- Collaboration with University of Strathclyde
- 4 technical presentations, from both industry and academia
- Visit to the Neilston substation.
- Phoenix project:
  - A hybrid solution combining Synchronous Condensers and Static Compensators technologies

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East Cambridgeshire Careers & Skills Event

- Our stand welcomed 1500 primary and secondary students
- Promote interests for power industry
- Inspire local young students on careers available in the power and energy sector

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CIGRE UK NGN 2020 YM Showcase 5th Feb 2020

- 10 candidates were shortlisted to present their work, 4 winners nominated
- Followed by a tour in UoM Electrical research labs (including the HV testing lab)

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Online Technical Webinars in 2020

- 17th June 2020, wind energy, in collaboration with CIGRE Ireland NGN, 4 speakers in total
- 5th August 2020, Chartership and career development, in collaboration with IEEE PES UoM student branch, 2 speakers from CIGRE UK.
- 12th August 2020, Career Management and Grid Modernization Workshop, in collaboration with CIGRE US NC, speaker from CIGRE US.
- 19th August 2020, Global and UK Energy Challenges and Opportunities for Young Members, in collaboration with University of Birmingham.
- 2nd October 2020, Offshore Wind Energy, in collaboration with CIGRE Denmark NGN, 2 speakers from UK, 2 speakers from Denmark
- 12th November 2020, Lightning Phenomena and Power System Transients, in collaboration with Austria NGN, 1 speaker from UK, 1 speaker from Austria

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Paris Session

- CIGRE's biennial Technical Congress and Exhibition in Paris
- In 2018, attracted 3290 delegates and 6600 exhibition visitors
- Hundreds of papers are collaboratively debated.
- Young Member Show Case is initiated by CIGRE UK NGN in 2016
- This provide NGN members opportunities to present their work

Upcoming Events

- LinkedIn page - https://www.linkedin.com/company/cigre-uk/
- Twitter - https://twitter.com/cigreukngn
- Newsletter subscription - https://cigre.org.uk/ngn/

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Relaunch: Mentoring Scheme

EXPERIENCE

CIGRE UK WORKING GROUPS

Group A – Equipment:
A1 Rotating electrical machines
A2 Power transformers and reactors
A3 Transmission and distribution equipment

Group B – Technologies:
B1 Insulated cables
B2 Overhead lines
B3 Substations and electrical installations
B4 DC systems and power electronics
B5 Protection and automation

Group C – Systems:
C1 Power system development and economics
C2 Power system operation and control
C3 Power system environmental performance
C4 Power system technical performance
C5 Electricity markets and regulation
C6 Active distribution systems and distributed energy resources

Group D – New materials & IT:
D1 Materials and emerging test techniques
D2 Information systems and telecommunication

KNOWLEDGE

CIGRE UK NGN Mentoring Scheme

CAREER DEVELOPMENT

DIFFERENT PERSONAL PERSPECTIVES

PROFESSIONAL NETWORK

FOR MORE INFORMATION PLEASE CONTACT membership@cigre-ngn-uk.org

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For power system expertise

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Lessons learnt from the COVID-19 Pandemic: How Resilient Are We?

Matthias Noebels

PhD Researcher

The University of Manchester

Dr Mathaios Panteli

Assistant Professor

University of Cyprus

Chair of CIGRE WG C4.47 “Power System Resilience”

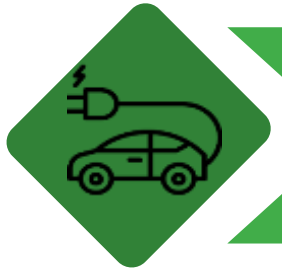
Impact of COVID-19 on electrical power systems

Joint webinar organized by CIGRE NGN United Kingdom and NGN Netherlands

Monday, 29 March, 2021

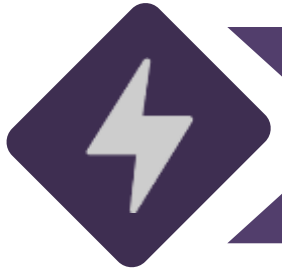
Increasing Shocks and Stresses: *Growing need for Resilience*

Rapid Changes and Stresses in Energy Landscape



Increasing Reliance on Reliable and Resilient Electricity

Increasing and Complex Interdependencies Between Critical Infrastructures



Threats and Shocks to Electricity Infrastructure

What is really a high-impact low-probability event?

“A bull with an itchy bottom knocked a transformer off an electricity pole as he tried to scratch his backside - and cut power to 800 homes.”

"We went up to feed our cows and it was my husband that noticed the transformer box had been knocked off the pole.

"We put two and two together and realised our bull had been scratching against the telegraph pole and he had knocked the box off the pole. All the wires were down in the field as well."

“Four-year-old Ron managed to avoid the box as it landed in his field, and escaped an 11,000 volt shock from the tumbling cables.”

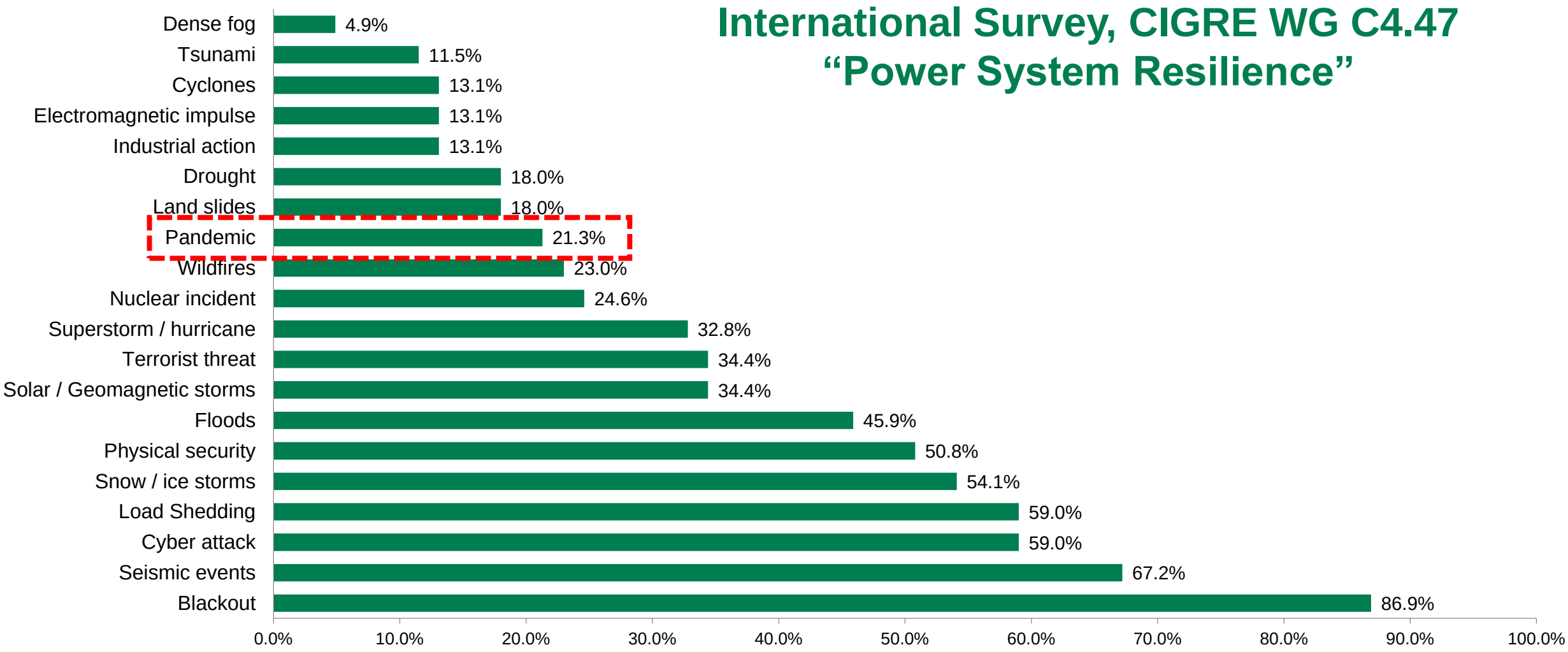
Bull's bid to scratch 'itchy bum' cuts off power to 800 homes

8 May 2020 Share

Ron has been relaxing in his field after his near-death experience

Source: https://www.bbc.co.uk/news/uk-scotland-glasgow-west-52591605

What is really a high-impact low-probability event?



CIGRE WG C4.47 Resilience Definition

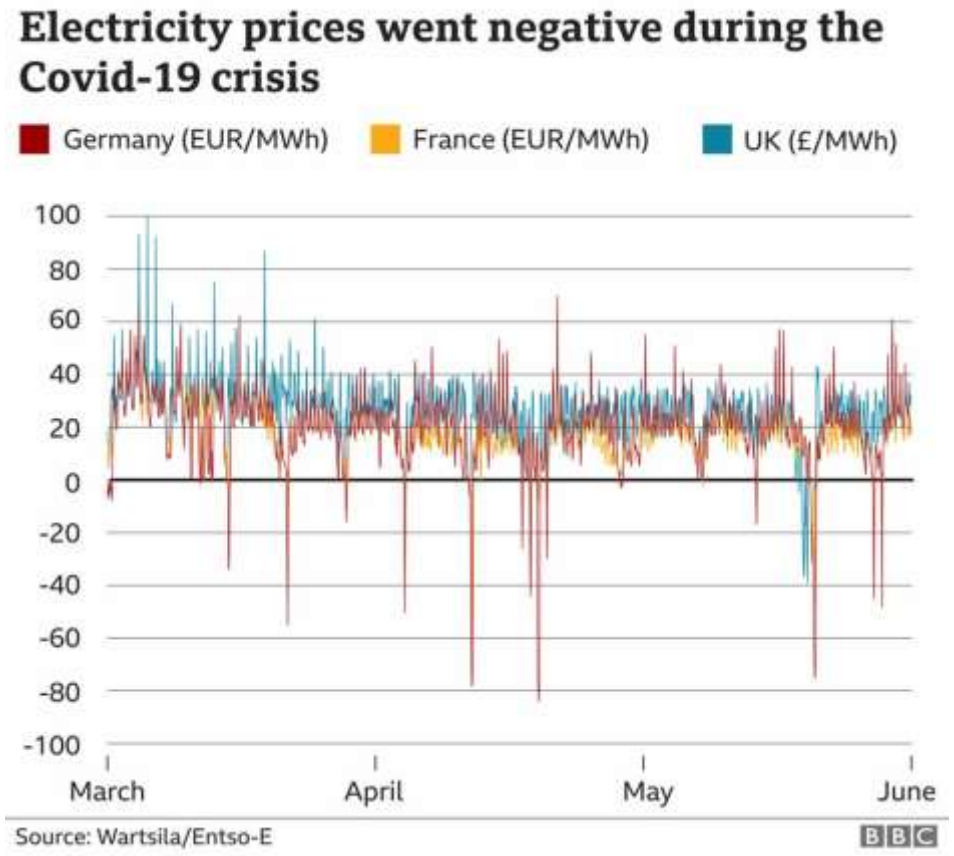
*the ability to limit the **extent, severity** and **duration** of **system degradation** following an **extreme event**.*

Anticipation	Preparation	Absorption	Adaptation	Rapid recovery	Sustainment of critical system operation
• the process by which newly incorporated knowledge gained is used to foresee possible crises and disasters	• the process through which grid operators establish a set of actions to be deployed in case the critical operating condition occurs	• the process through which a set of measures is deployed to limit the extent, the severity and the slope of the degradation of power system performance	• the process through which changes are carried out in the power system management procedures, on the basis of past disruptions, in order to adjust the system to undesirable situations	• the process through which the energy supply to the customers is restored and the damages to the grid infrastructure are repaired	• the process which deploys the measures allowing an impaired power system to supply a minimum system load level in order to maintain a reduced but acceptable functioning of everyday life

Acknowledgments: Emanuele Ciapessoni, Diego Cirio and Andrea Pitto, RSE, Italy

Covid-19 Pandemic: Going beyond “typical” HILP events

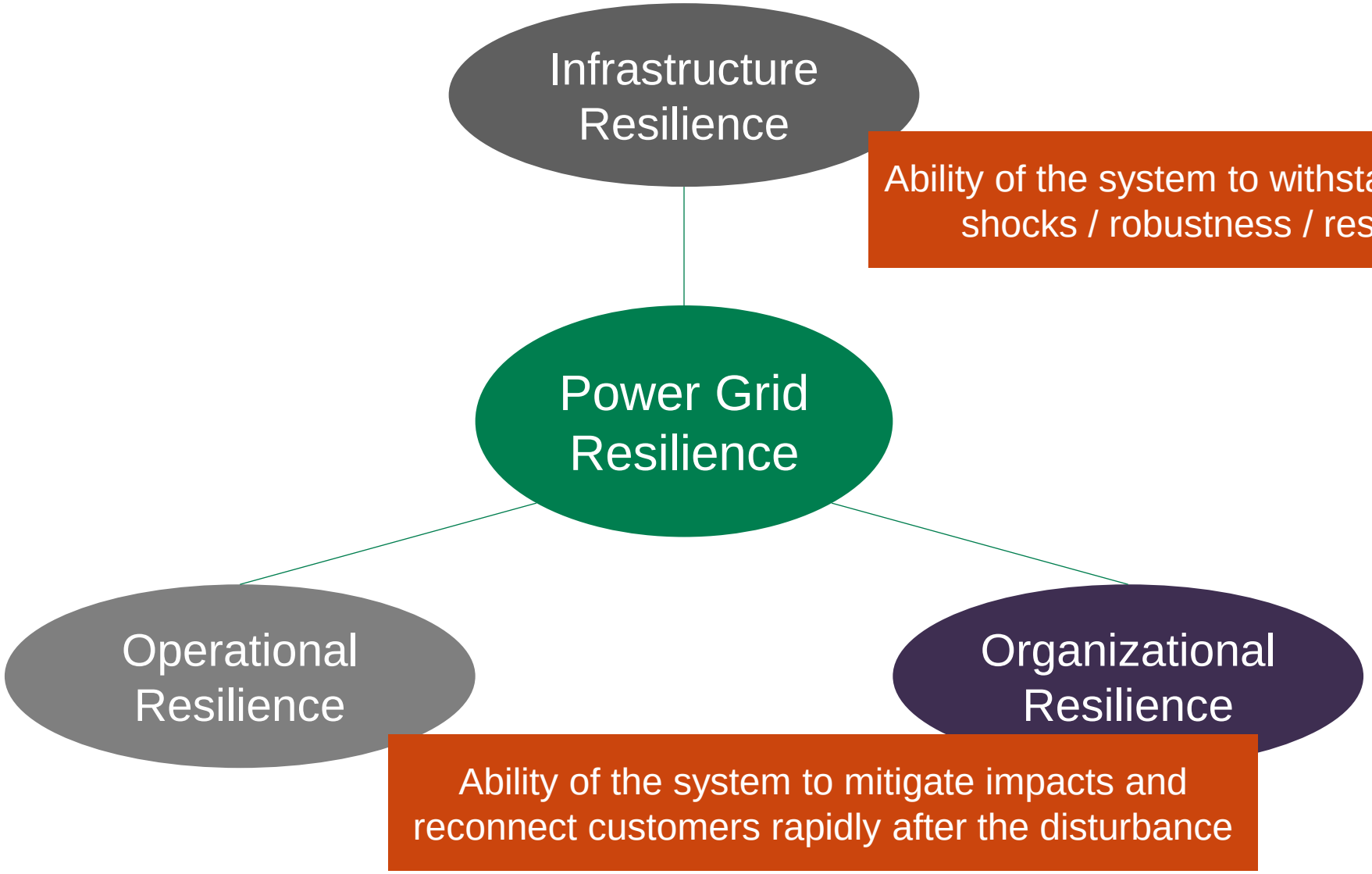
- During the coronavirus lockdown, electricity consumption was down across Europe by around 15%.
- Wholesale electricity across Europe is priced on an hourly basis for the day ahead, so abundant (renewable) supplies and weak demand saw prices go below zero at times.
- Consumers who had signed up to flexible, real time tariffs with one UK energy supplier found themselves encouraged to use electricity when it went negative.
- Social, generation and network planning/maintenance impacts, etc. etc.



Source: https://www.bbc.com/news/science-environment-52943037

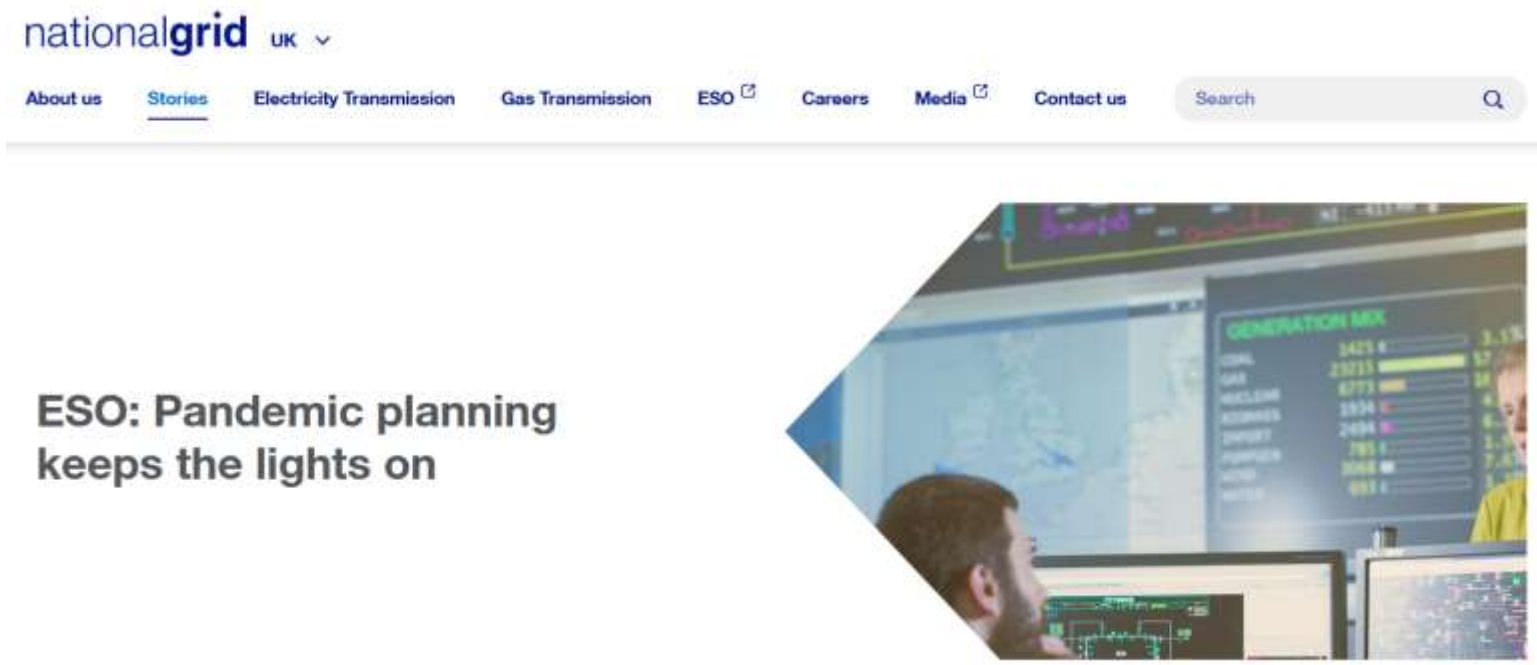
"But faced with this, and the challenges of staff getting ill and having to go off into isolation, just keeping the lights on and keeping the electricity system operating through this is a minor miracle in itself."

Is infrastructure and operational resilience enough?



Organizational Resilience

- Organizational resilience: refers to the underlying mechanisms and strategies keeping the infrastructure together, is a fundamental step towards achieving the three essential capabilities of a resilient system, namely *absorptive, adaptive and restorative capacities.*
- Essential in having key staff available, and in swiftly mobilising measures to support, protect and empower this staff to sustain rapid response and recovery and limit exposure to the virus.
- Such provision is imperative to ensure the smooth, safe and secure execution of operations, maintenance and construction activities to ensure electricity provision.



One Year of Covid-19 Experiences: Lessons learnt – or not learnt yet?

New cascading and mathematical models for better understanding and quantifying resilience

Real data analysis for performance and correlation analysis with shocks and stresses

Data-driven resilience analysis of power grids against external shocks and network stresses

Resilience-driven investment, policy and regulatory decision-making

Multi-phase Resilience Assessment and Enhancement

Bowtie diagram

Before

Long-term Planning
- Transmission expansion
- Reinforcement

Short-term Control
- Dispatch
- Preventive islanding

Prevention

Event

Mitigation
- Frequency and voltage protection
- Load shedding

After

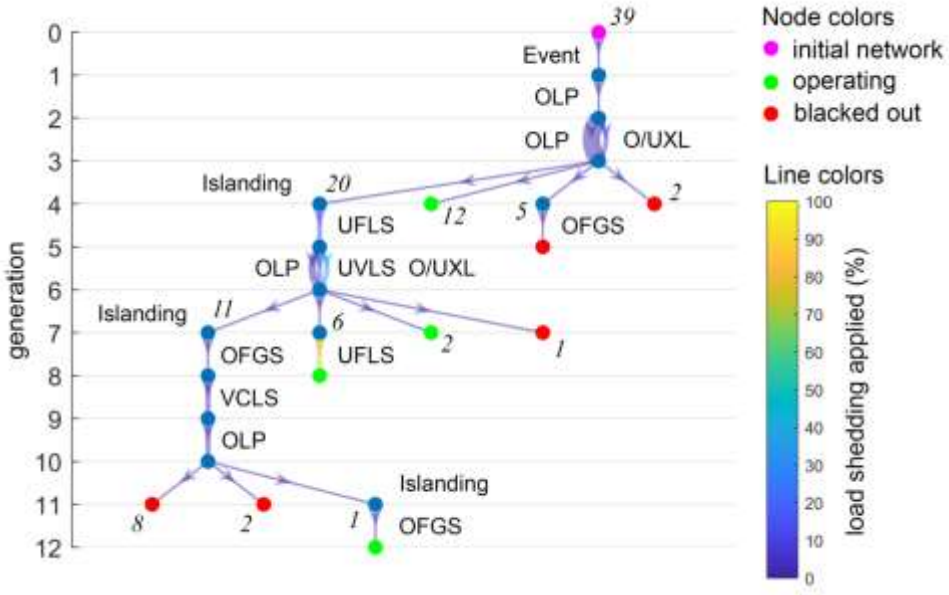
Restoration
- Black start generators

Recovery

Adaption
- Analysis and evaluation
- Optimisation

Simulating Resilience Events

New cascading and mathematical models for better understanding and quantifying resilience



Reliable simulation of event phase crucial for resilience assessment and enhancement

AC Cascading Failure Model for Resilience Analysis

- Specifically designed for resilience analysis
- Seamless integration into established frameworks
- Stable for large contingencies and extreme network conditions
- Thoroughly validated
- Computationally fast

Code available via Github:
github.com/mnoebels/AC-CFM

Model can be used to assess network resilience under "Covid conditions"

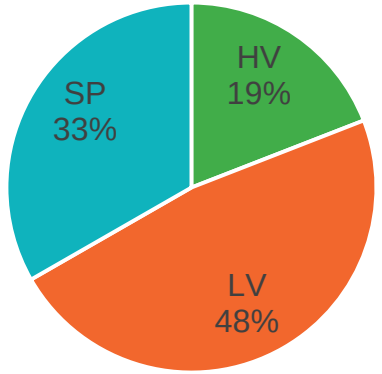
- Changed demand
- Repair times

M. Noebels, R. Preece, M. Panteli, "AC Cascading Failure Model for Resilience Analysis in Power Networks", IEEE Systems Journal (2020)

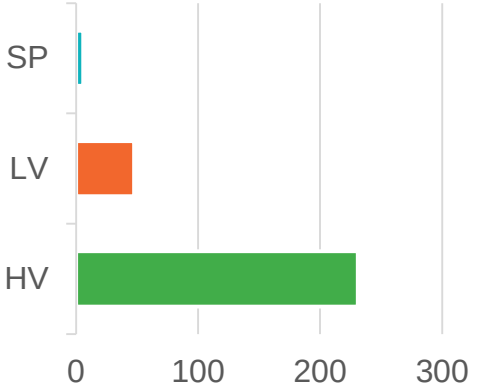
Assessing resilience from UK outage data

Real data analysis for performance and correlation analysis with shocks and stresses

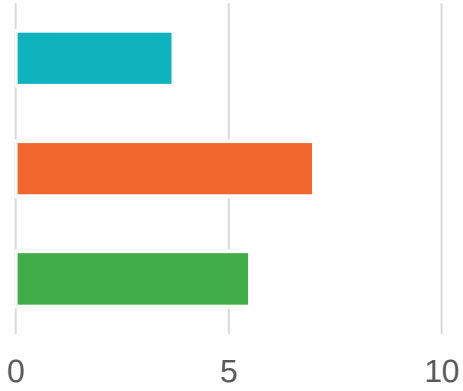
Number of power cuts



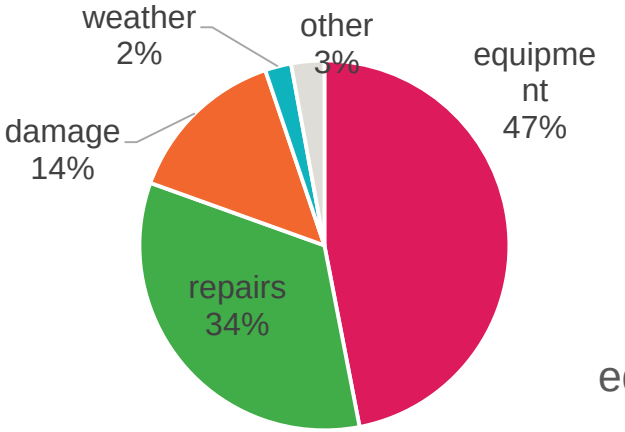
Customers per power cut



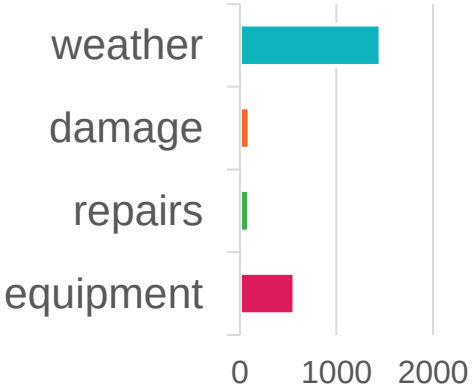
Avg. duration per power cut (h)



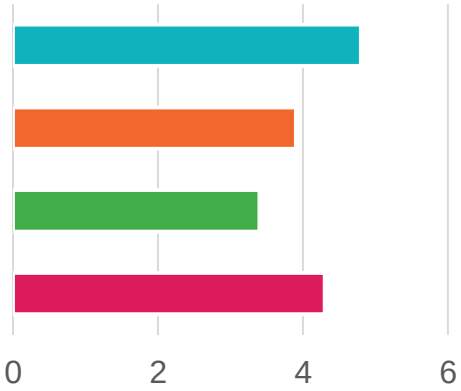
Number of power cuts



Customers per power cut



Avg. duration per power cut (h)



M. Noebels, M. Panteli, “Correlations of Shocks and Stresses with Distribution Network Outages”, IEEE PES GM (2021, accepted)

Assessing resilience from UK outage data

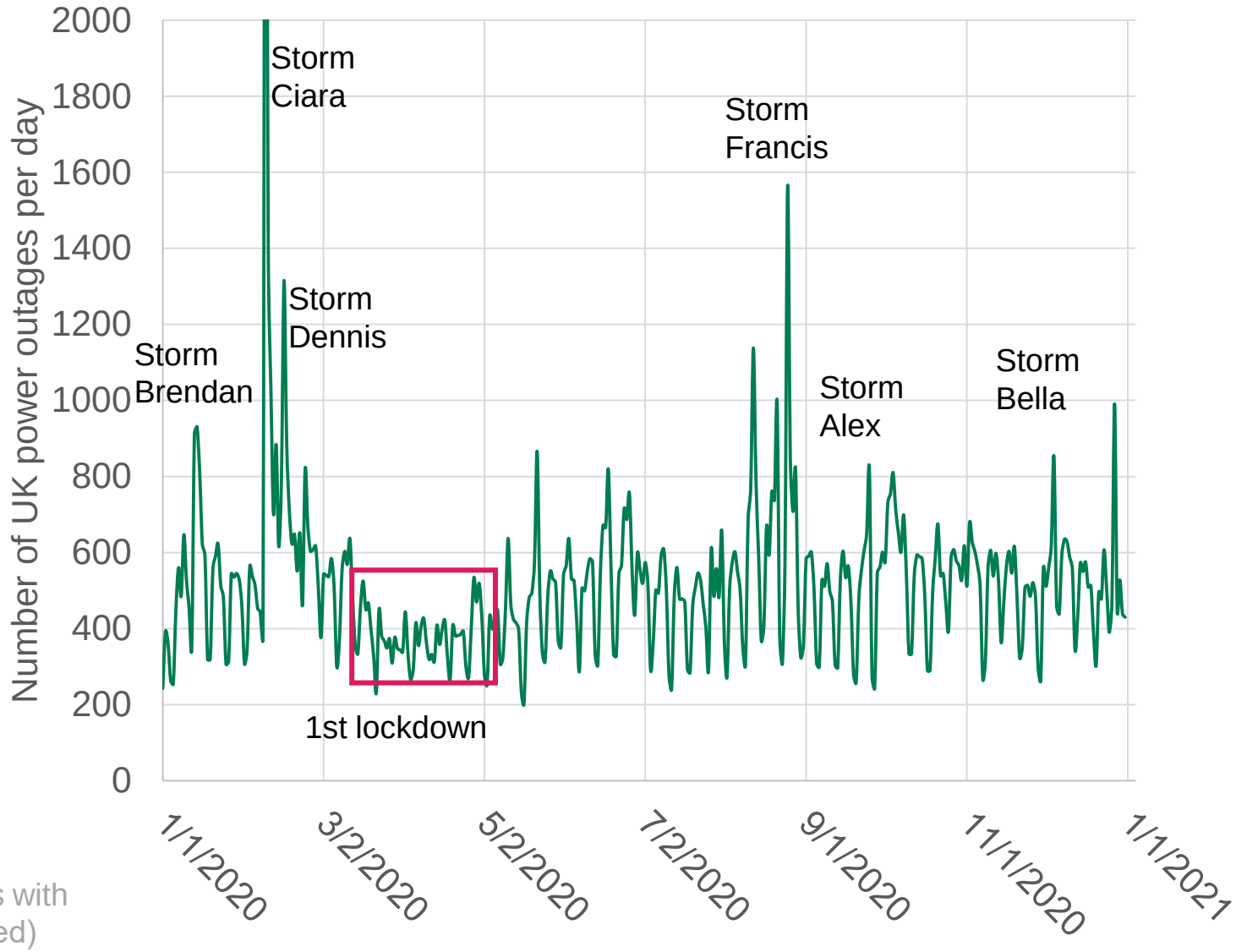
Real data analysis for performance and correlation analysis with shocks and stresses


COVID-19 FOOTBALL NEWS CELEBS TV POLITICS SPORT FILM RO

Coronavirus crisis blackouts warning as families told to keep torches on hand

UK Power Networks has urged some of its customers to keep a torch handy, warm clothes nearby and their fridges shut to ensure medication stays cold amid the prospect of blackouts because of coronavirus

SHARE COMMENTS



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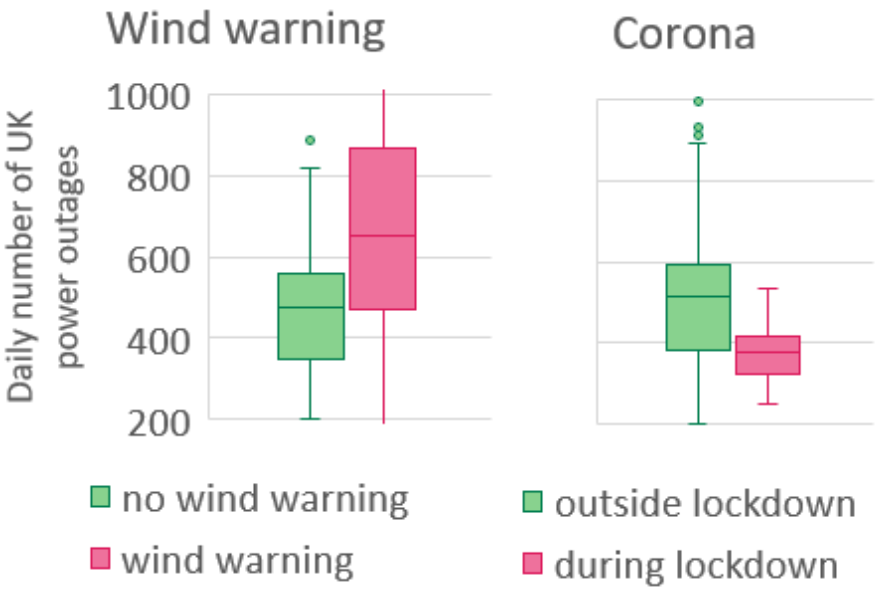
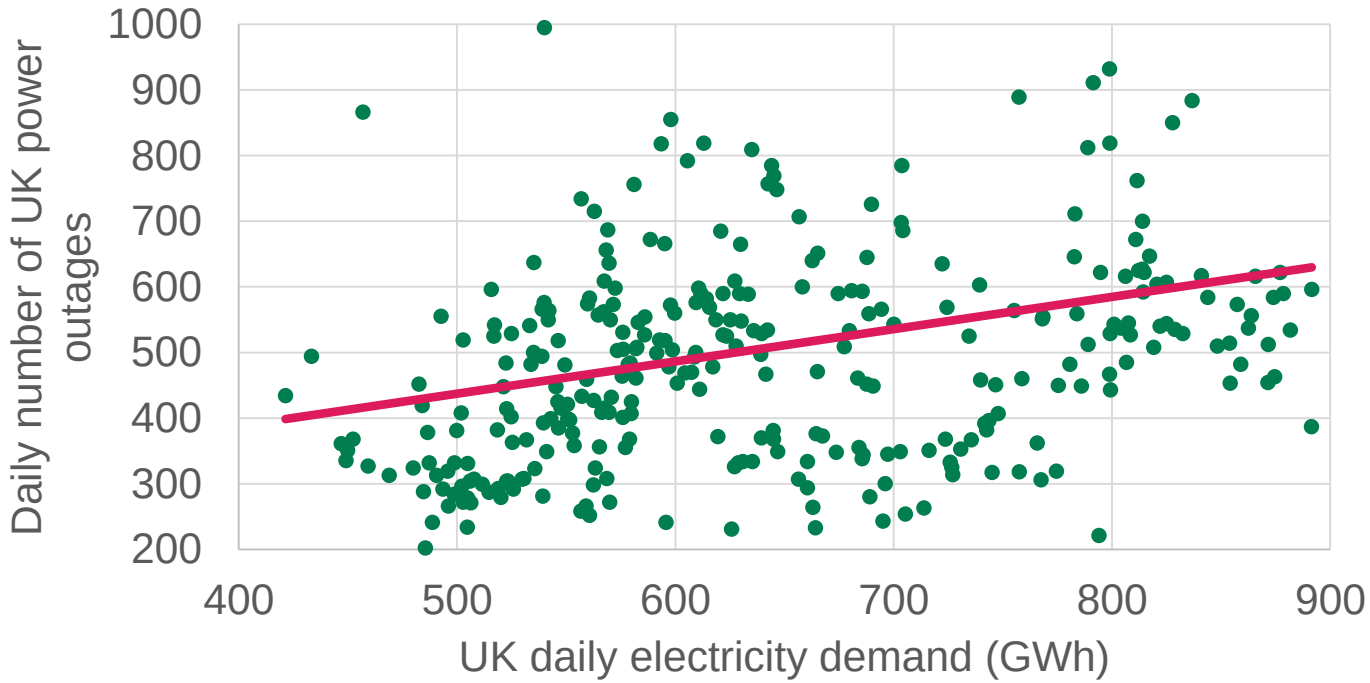
Assessing resilience from UK outage data - Correlations

Real data analysis for performance and correlation analysis with shocks and stresses



Simulation and historical outage data suggest that higher demand correlates with more power outages



M. Noebels, M. Panteli, “Correlations of Shocks and Stresses with Distribution Network Outages”, IEEE PES GM (2021, accepted)

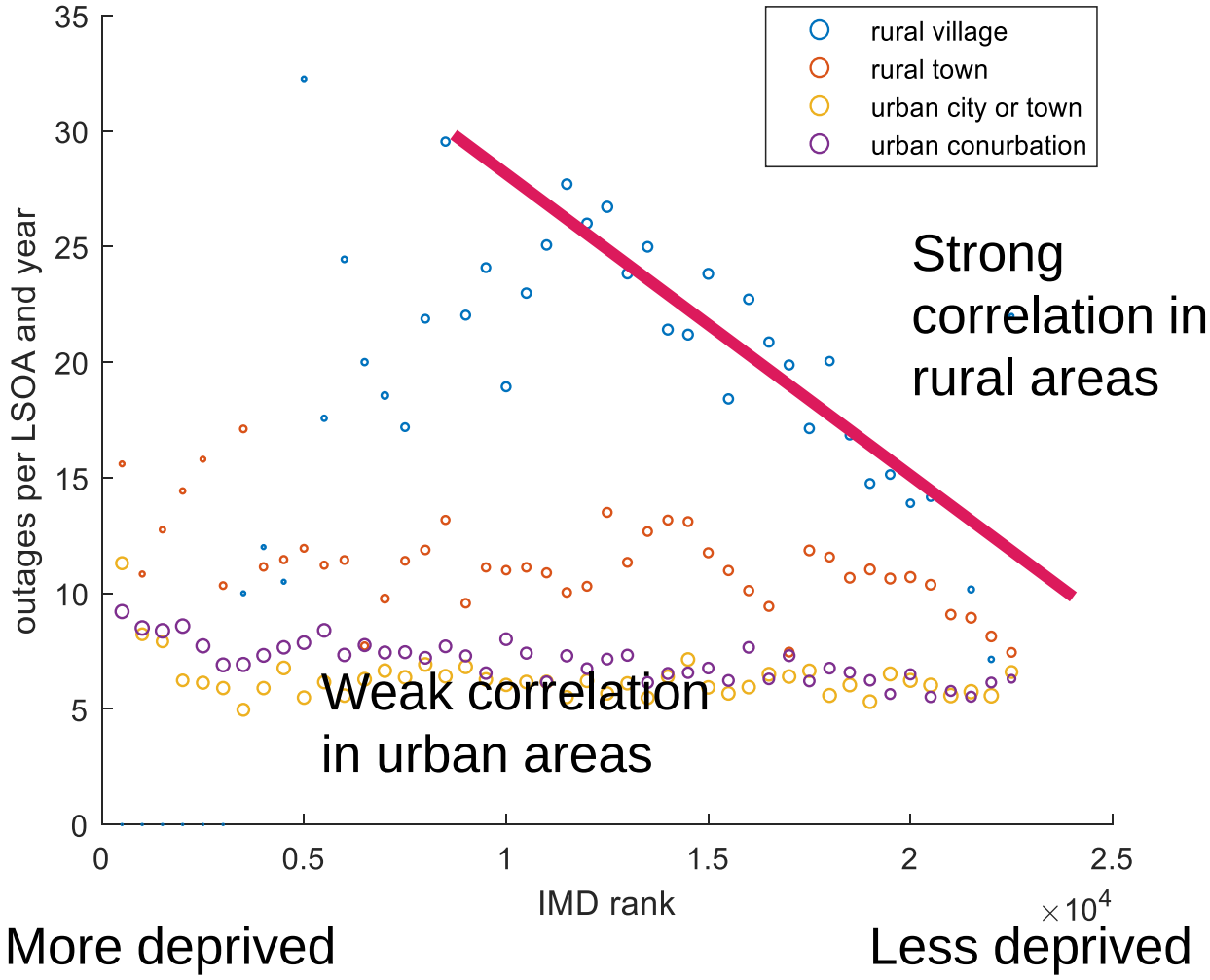
Assessing resilience from UK outage data - Correlations

Correlating power cuts with social metrics

LSOA – geographic hierarchy, areas of approximately similar population size

Index of Multiple Deprivation

- Income
- Employment
- Education
- Health



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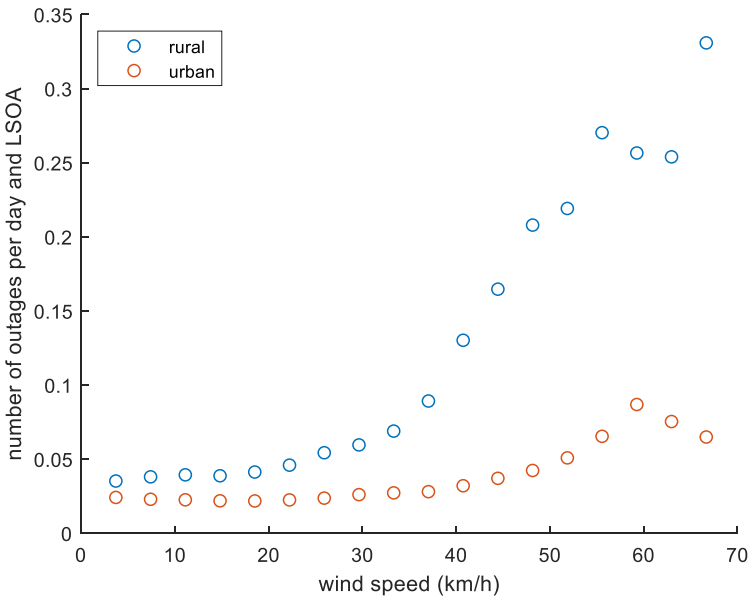
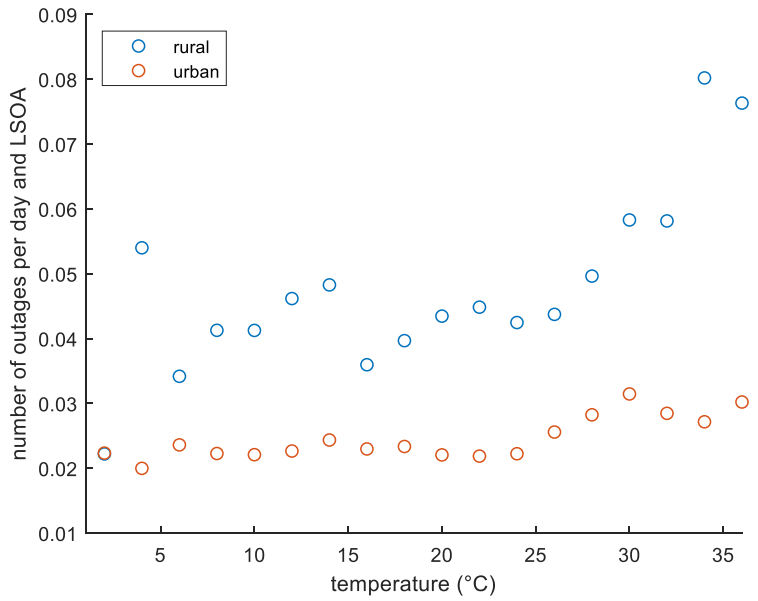
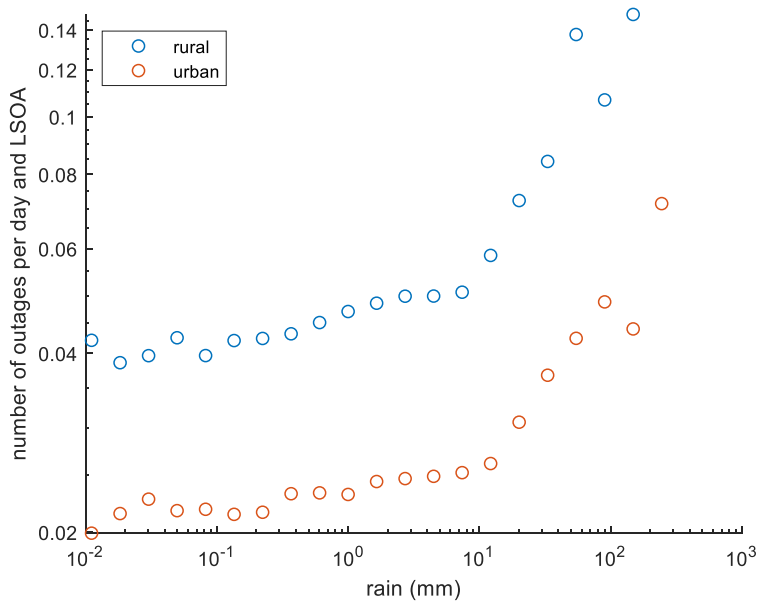




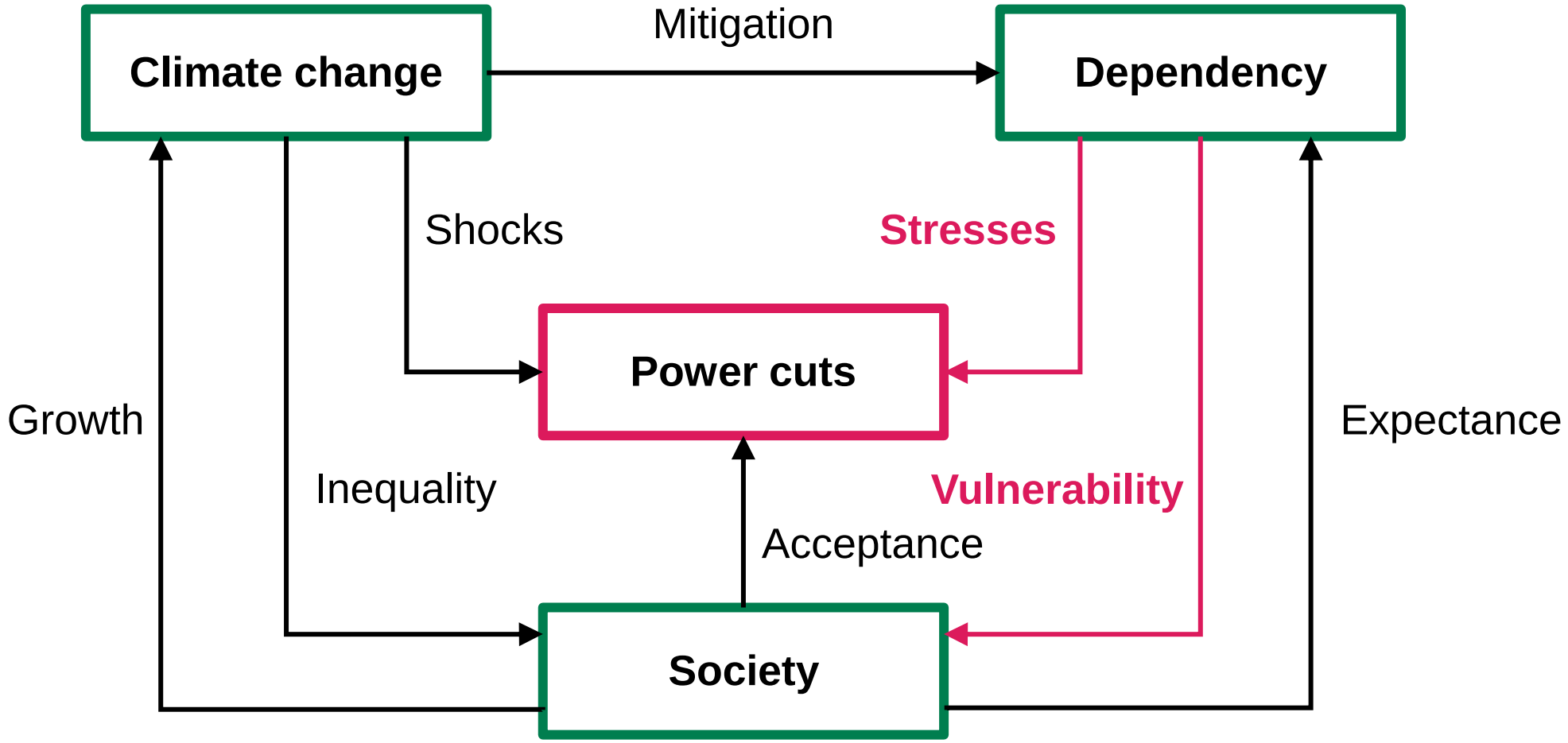


Rural areas are much more susceptible to power outages due to extreme weather

- Extreme wind
- Extreme temperatures
- Extreme rainfall

Climate change will increase stress on rural communities

Resilience-driven investment, policy and regulatory decision-making



Resilience-driven investment, policy and regulatory decision-making

- **Fairness of measures – leaving no one behind**
  - Support for rural communities and vulnerable groups
  - Public consultations
  - Include acceptability of power cuts in performance metrics
- **Diversity of measures – don’t rely on only one technology**
  - Climate change mitigation relies heavily on electrification
  - Implement supporting or compensating technologies
- **Distribution of measures – tailor solutions to individual needs**
  - Community resilience schemes
  - Priority service registers with financial penalties

Community resilience

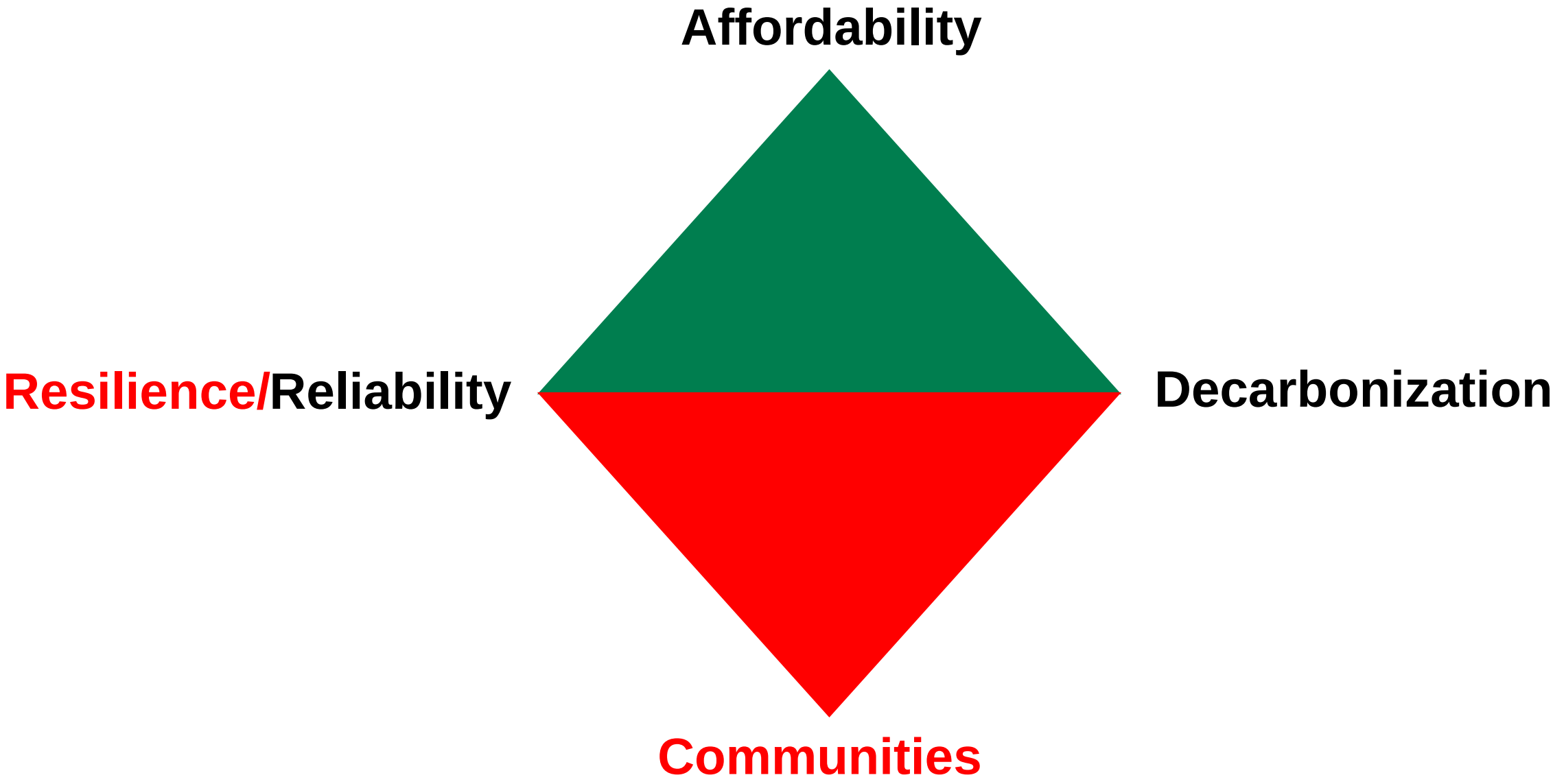
- Experience from the pasts shows that UK has good levels of network resilience, but has lack of community resilience
- Community resilience is “the ability to utilise available resources to cope with adverse situations”
  - Neighbourhood solidarity and sense of community
  - Local knowledge and resources
  - Communication strategies
  - Small-scale generation and storage

- Is reacting to events and investing in network hardening measures to create a system that never fails the most resilient- and cost-effective approach?
- Should we be more geared towards incentivizing and improving community resilience in order to enable and further enhance community preparedness and response to a power outage?

Role of communities against HILP events…including pandemics

- Determine which groups must be engaged as stakeholders
- Articulate objectives of engagement for each stakeholder group
- Apply a tailored approach for each stakeholder group
- Engage end-users in all stages of decision-making in design resilient community energy systems against HILP events

Re-Rethinking energy trilemma…energy quadrilemma?



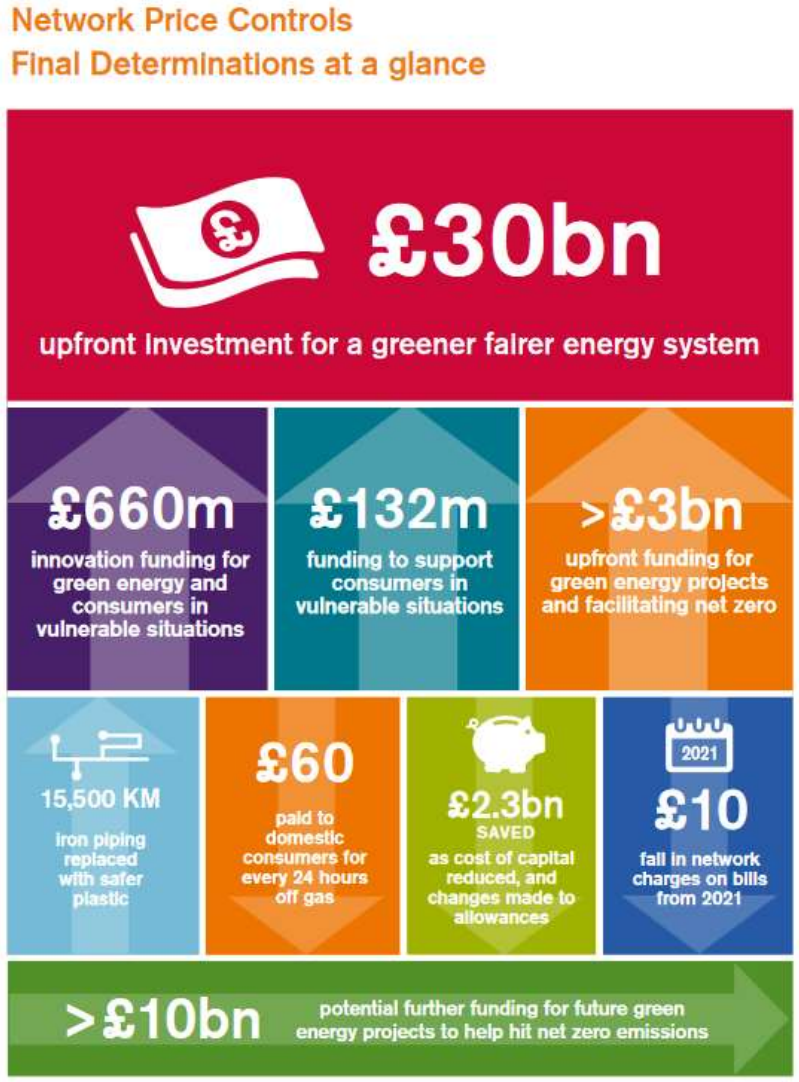
UK Ofgem Regulatory Agenda RIIO-2 (2021-2026)

"The networks need to remain resilient to a range of existing and emerging threats. This resilience encompasses the physical condition of the assets, as well as the capacity to withstand external threats such as flooding of key sites or cyber-attack."

Network Resilience

Asset Resilience	Environmental resilience	Information/ other resilience
Network Asset Risk Metric (NARM)	Climate resilience	Workforce
	Flooding	Cyber
	Tree cutting	Electricity System Restoration*
	Resilience metric	Physical Site Security
		Telecommunications

https://www.ofgem.gov.uk/system/files/docs/2020/12/riio_ed2_ssmd_annex_1_delivering_value_for_money_services_for_customers.pdf



https://www.ofgem.gov.uk/system/files/docs/2020/12/riio2_overview_document_web_1.pdf

Concluding Remarks

- The COVID-19 pandemic impacted almost all aspects of power system operation and planning.
- In combination with other HILP events during the last years, it raised the issue that we need, as industry, to rethink our approach in planning, operating and regulating power systems.
- Data-driven approaches are necessary to better understand and design the infrastructure and underlying mechanisms with and for the communities.
- Beyond electricity systems: cross-sectoral coordination and emergency planning to deal with large-scale crises

Further Reading

- Noebels, M., Preece, R., and Panteli, M. "AC Cascading Failure Model for Resilience Analysis in Power Networks." IEEE Systems Journal (2020).
- Noebels, M., Panteli, M., “Correlations of Shocks and Stresses with Distribution Network Outages”, 2021 IEEE Power and Energy Society General Meeting, Accepted for presentation
- Noebels, M., Panteli, M. “Community resilience – Are we unable to deal with power cuts?.” http://blog.policy.manchester.ac.uk/energy_environment/2019/11/community-resilience-are-we-unable-to-deal-with-power-cuts/
- Noebels, M., Peesapati, V., Panteli, M. “How organisational resilience helps in dealing with COVID-19 and large-scale crises.” https://www.mub.eps.manchester.ac.uk/science-engineering/2020/04/28/guest-post-how-organisational-resilience-helps-in-dealing-with-covid-19-and-large-scale-crises/
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THANK YOU – ANY QUESTIONS?

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Next Generation Network – The Netherlands

Luis Hurtado

NGN NL

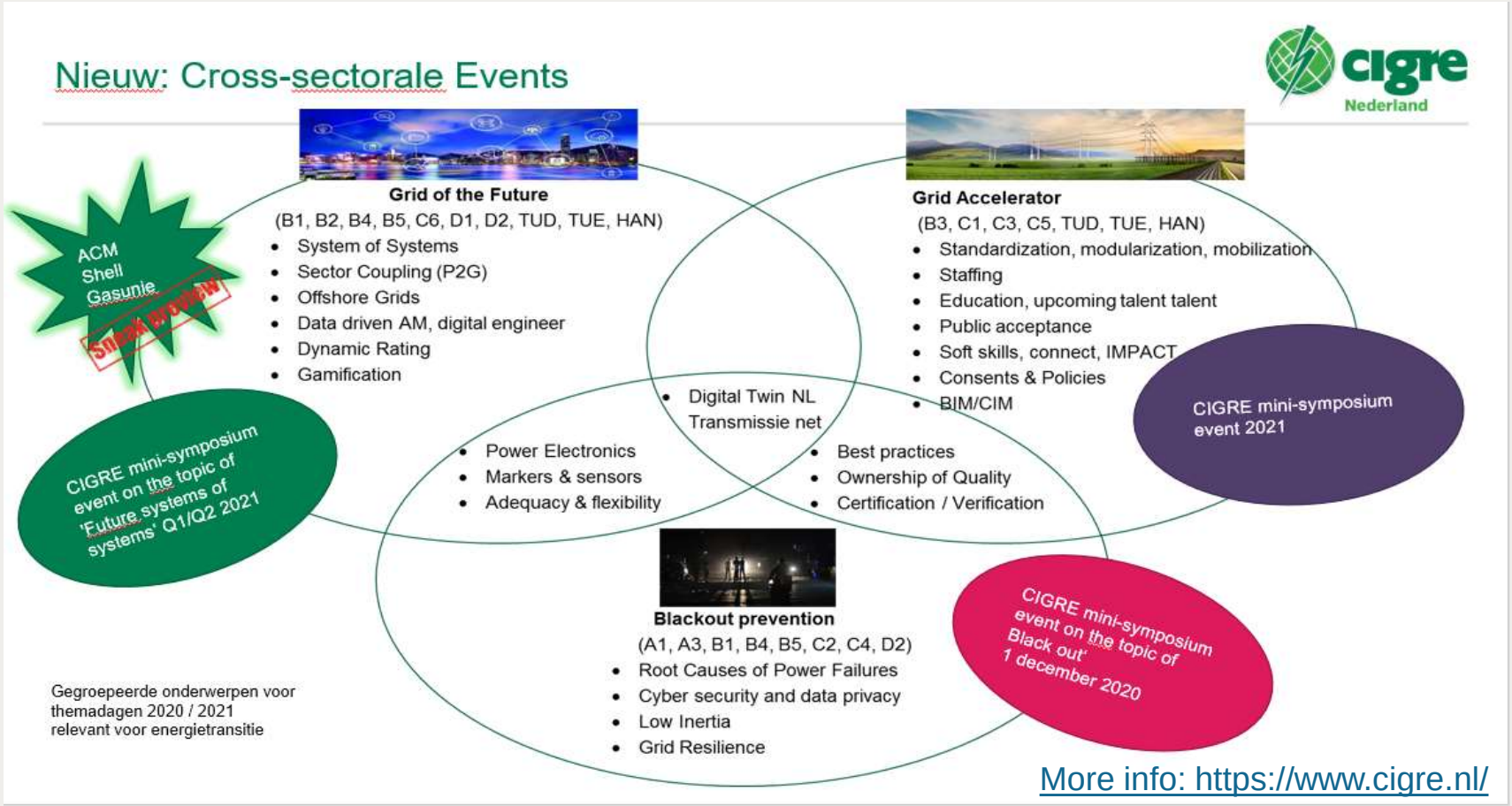
also referred to as young CIGRE, the Netherlands (YC-NL)

- Established in the year 2014
- Mission: NGN NL seeks to facilitate a successful transition into the power systems industry for early career professionals and students by providing technical resources and networking opportunities
- 9 board members
- 160 active subscribers.
- NGN member advantages:
  - Access to technical brochures and publications via the online library www.e-CIGRE.org
  - Matchmaking
  - Networking
  - Personal Development

NGN NL (Events)

- YC team networking day (Dive into the wind saga)
- YC matchmaking event (Annual event)
- Symposiums (e.g., Kabeldag)
- Participation in CIGRE Paris session – student support (Biennial event)

CIGRE NL Themes 2020/21



Join NGN NL: https://www.cigre.nl/becoming-a-young-cigre-member/

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Young CIGRE NGN Impact Covid Measures TenneT

Jan Vorrink, Head Control Centres NL

Contents

TenneT at a glance
2019

Workforce
4,913
Employees

EBIT
768
EUR million

Assets
21,8
EUR billion

Investments 2019-2029
35
EUR billion

Grid
99,99%
Availability

Grid length
23,555
Km

Dutch State
100%
Shareholder

Footprint
27.4%
Greened

TenneT at a glance
2020

Workforce
5,700
Employees

EBIT
796
EUR million

Assets
27
EUR billion

Investments >2025
5-6
EUR billion/year

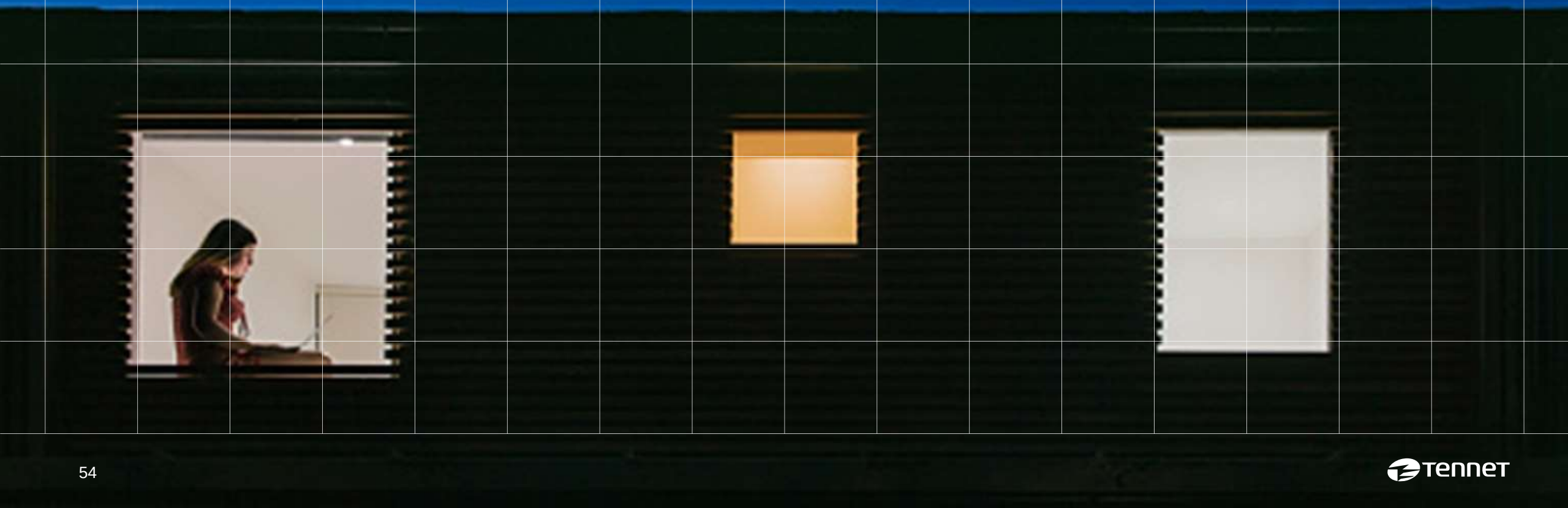
Grid
99,9999%
Availability

Grid length
23,900
Km

Dutch State
100%
Shareholder

Footprint
27.4%
Greened

99.9999%
grid availability 2020



Most important Impact of Covid-19 on Electricity system

- In countries with total lockdown relevantly decreased load
- Decreased load leads to high voltages
- Decreased loads lead to very low prices when solar PV and/or wind have high production
- Low and Negative prices lead to switching of synchronous conventional generation, this can lead to voltage (stability) and inertia problems.
- TSO’s facing voltage and inertia problems can mitigate these risks by contracting must run units and stimulating trades of energy to other countries which can lead to increased problems in these countries.
- COVID precautions can lead to less maintenance activities
- Travel restrictions can lead to international supply chain problems which can lead to shortages in materials for maintenance and projects.
- Travel restrictions make quality assurance and audits more difficult.

Most important Measures Covid-19

- Corona Continuity team meeting first daily and now once a week on Tuesday – 1 March 2020
- No more travelling for employees – 3 March 2020
- Access employees Control Centres NL and Germany adapted – 13 March 2020
- Work in Control Centre Departments continues with significantly less staff
- All critical roles split in 2 teams which operate seperately
- CORONA crisis team installed and frequent meetings
- COPA team meetings weekly from 3 April 2020
- Registration off all staff present in offices
- During lockdown travel permets issued
- ENTSO-E monthly survey – 22 April 2020
- Coordination with other TSO’s

Press releases on TenneT.eu

As a company responsible for critical infrastructure, TenneT takes the risks posed by COVID-19 (‘corona virus’) very seriously

The Electricity Transmission System Operators of Austria, Belgium, France, Germany, Italy, Netherlands, Spain and Switzerland are regularly coordinating their efforts to do the utmost to limit the consequences of the Covid-19 pandemic on people, electricity supply and the economy in Europe. “We need to jointly ensure the stability of the electrical system, the service continuity and the operation of our network infrastructures, which represent the real backbone of the interconnected electricity system on a continental scale”, the CEOs of the high-voltage system operators are saying jointly . “Energy has always been an essential component of European partnership. While the COVID-19 pandemic is impacting the life of our citizens and the European economy with full force, electricity remains more than ever crucial for daily life, health services and more generally to all critical activities.”

We are proud of the fact that the second part of the Borssele high voltage connection is already complete and was realized within budget. Despite all the Covid-19 challenges, we were successful in continuing with the works; a huge achievement from all the contract parties involved.”

An example off COPA team risk assessments
Executive summary

Starting point/ assumptions

Performing several analyses, we inter alia dealt with the question if **SOP objectives** will be sustainable under certain scenarios.

Two scenarios were identified as most relevant
- **30%+ absence rate** (internal/ external staff)
- **government measures** plus 3 months

Focus on potential **high impact items** as well as respective **measures**.

Link to corona

Maintainability of SOP tasks - esp. in control centers - will depend primarily on severity of **virus spread** within TenneT's and key service providers' personnel.

Furthermore, nature and duration of **government measures** might become more important in the medium term (maintenance works in the grid and power plants as well as supply chain disruptions).

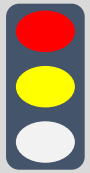
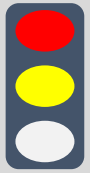
Executive summary

Strategic pillars potentially affected in light of the scenarios:
- **security of supply** (core process "operate electricity grid") and on the periphery
- **energy transition** (core process "build electricity grid")

Main **potential** risk areas/ **top items** if scenarios materialize:
- General susceptibility to error due to fading staffing levels
- Deteriorated ability to maintain operations and market coordination
- Lacking hard- and software IT support (internal/ external) in case of incidents
- Loss of own assets as well as production and/ or reserve capacity

Currently, as **preventive measures** have been taken and until now are effective, no immediate impact on effectiveness of core processes has occurred. Grid stability is **not** at imminent risk. Looking at potential effects of selected scenarios, **critical absence rate** of staff would lie between 30 and 50% - also depending on duration.

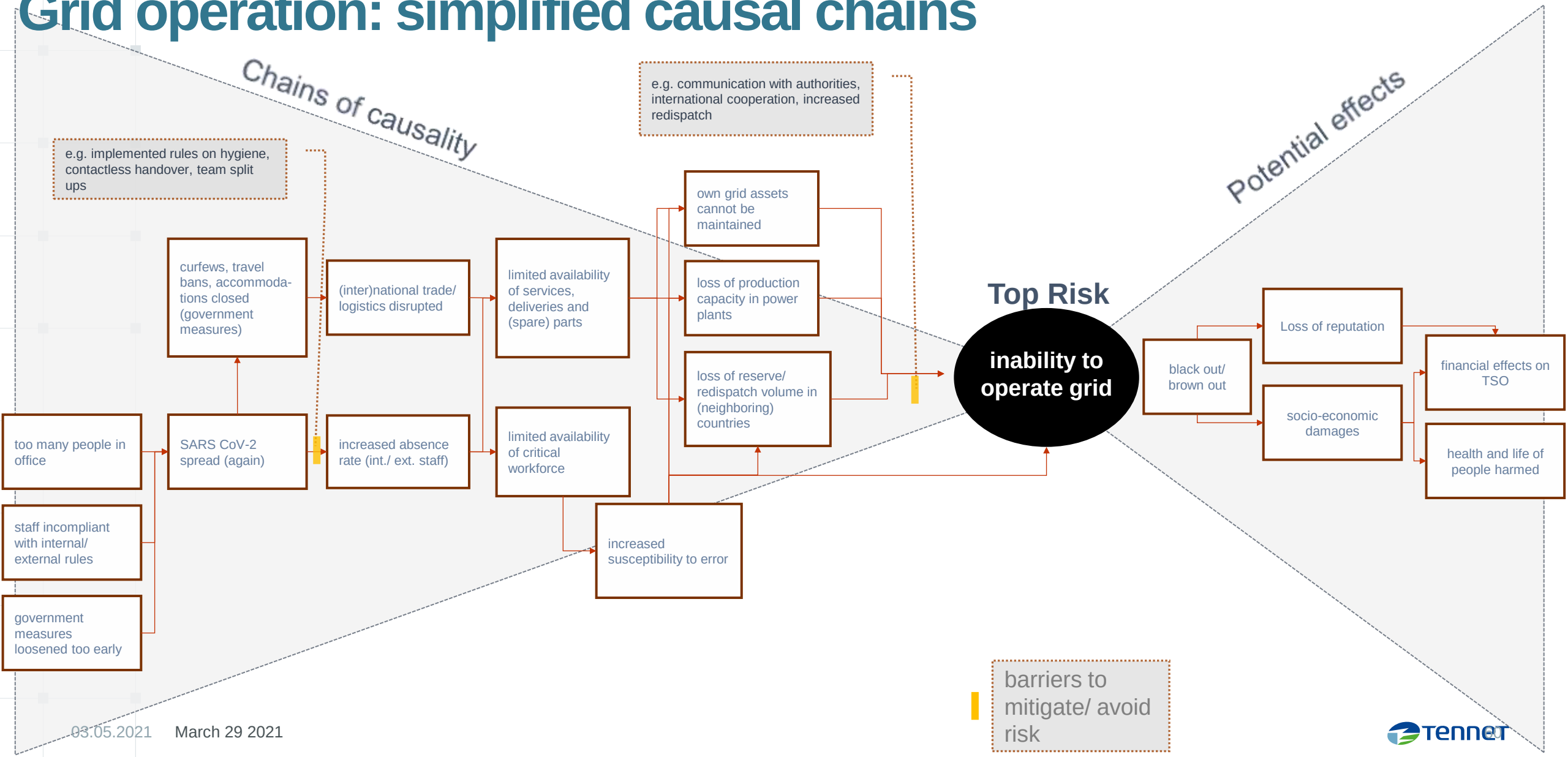
Top items and measures in case scenarios materialize

	Top items	Measures
Absence rate ≥ 30%  *overall assessment of scenario*	Increased susceptibility to error and/ or lowered ability to maintain operations and market coordination to usual extent Endangered hard- and software IT support (internal/ external resources) in case of loss of control and telecommunication systems	Adapt staff planning/ deployment incl. testing policy, protection and containment measures Minimize planned outages and switching tasks Reduce EEG infeed, focus on “must run units” to avoid congestions and achieve x>1 Exploit redundancies (HR, locations, systems) Substations to be manned if possible Enable experts to work from home (even with mild symptoms)
Government measures +3 months  *overall assessment of scenario*	Loss of own grid assets (maintenance, workforce, materials, spare parts) Loss of production capacity in power plants (maintenance, workforce, materials, spare parts) Loss of reserve/ redispatch volume in neighboring countries (for GE) and the south of the NL	Increased redispatch needed (brown outs possible) Inform regulators/ authorities about tight planning and limited flexibility (like in case of nuclear power plant Grohnde) Increase international cooperation and call for Critical Grid Situation process.

Potential opportunities

- Pandemic lessons learned plan
- Reduced travel time and cost
- Digital way of working incl. online training

Grid operation: simplified causal chains



Monitoring factors in case scenarios materialize

What?

- Regional SARS-CoV-2 reproduction (R0) and infection rates
- Actual absence rates and deltas (internal/ external)
- Availability of “must run units”/ forecasting
- Availability of redundancies including markets/ production
- Vacation planning / retrievability of staff

How?

- Publicly available data (e.g. prices)
- Internal data/ forecasts
- Absence rates
- Alignment with service providers and authorities
- Perform preventive and antibody testing
- Take into account special needs of SOP

When?

- As soon as increasing absences or other changes in key risk indicators are observed
- Continuous monitoring

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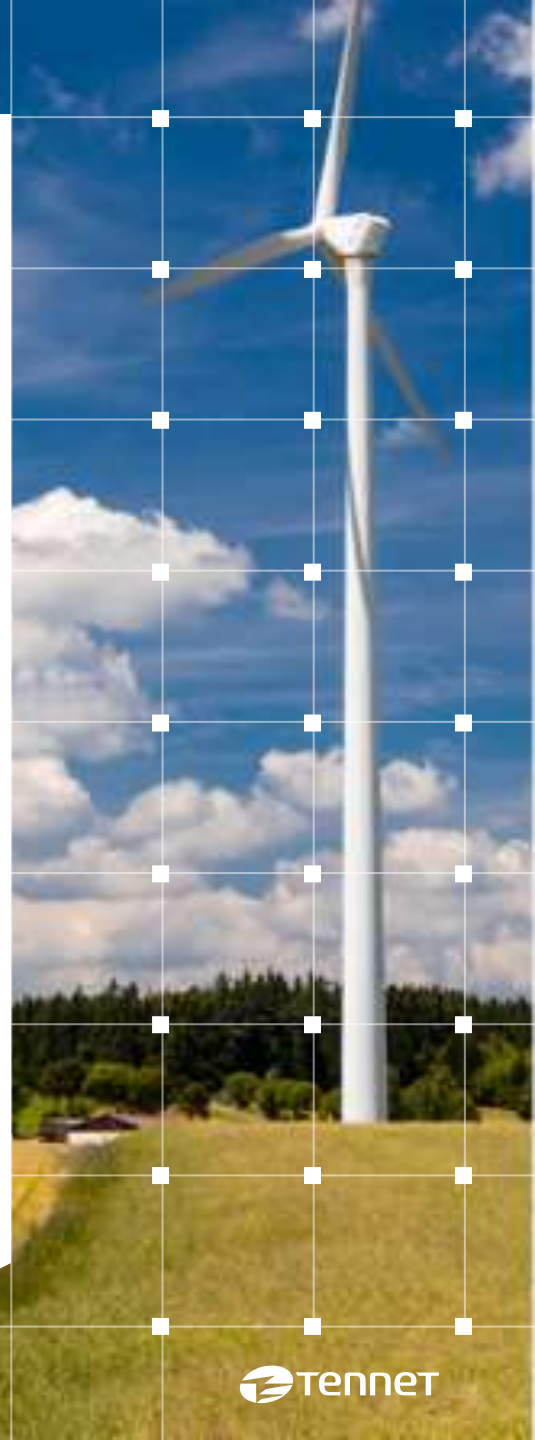
TenneT is a leading European grid operator (Transmission System Operator, TSO). We design, build, maintain and operate the high-voltage electricity grid in the Netherlands and large parts of Germany and facilitate the European energy market. We are committed to providing a secure and reliable supply of electricity, today and in the future, 24 hours a day, 365 days a year and to playing our role in driving the energy transition. We transport electricity over a network of approximately 23,500 kilometres of high-voltage connections, from wherever and however it's generated, to over 42 million end-users while keeping electricity supply and demand balanced at all times. With close to 5,000 employees, we achieve a turnover of 4.1 billion euros and a total asset value of EUR 23 billion. TenneT is one of the largest investors in national and international onshore and offshore electricity grids. TenneT makes every effort to meet the needs of society. This will require us all to take ownership, show courage and connect with each other.

www.tennet.eu



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Thank you!

https://www.cigre.nl/mission-young-cigre/

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